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Research Article

Genetic variability and heritability study on yield and its component traits in segregating population of cowpea (*Vigna unguiculata* L. Walp)

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Abstract
Experiment on genetic variability parameters *viz*., phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2) and genetic advance as per cent of mean (GAM) for yield and yield attributing traits such as days to 50% flowering, plant height (cm), number of clusters per plant, number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, hundred seeds weight (g) and seed yield per plant (g)in nine F_2 populations were studied. The results revealed that high h^2 and high GAM were recorded for plant height (cm), pod length, seeds per pod, hundred seeds weight (g) and single plant yield (g). High level of PCV and GCV were observed for number of branches per plant, number of clusters per plant, number of pods per plant and single plant yield (g).Low level of PCV and GCV were obtained for all the crosses except for cross IV (CO4 × VCP-09-024). Results suggest that quantitative traits like number of branches per plant, number of clusters per plant, number of pods per plant and single plant yield (g) can be used as selection criteria for yield improvement in F_2population of cowpea.

Keywords
Cowpea, heritability, PCV, GCV, GAM

Introduction

Cowpea (*Vigna unguiculata* L. Walp) is an important versatile legume crop and widely cultivated in semi-arid tropics namely Africa, Central and South America and Asia (Kapravelou *et al.*, 2015). It is photo-insensitive and drought tolerant crop with deep root system. Hence it can be grown throughout the year. All parts of cowpea used as food and fodder. The tender shoot tips and leaves during seedling stage, immature green pods and seeds during fruiting stage and dry seeds can be consumed as food. Seeds are an important sources of protein (18-35%), carbohydrate (50-60%) and crude protein (23%) and also rich in important vitamins, minerals, and soluble and insoluble dietary fiber. Cowpea is mostly cultivated as sole crop and mix-crop in India, and also an ideal crop for soil and water conservation because of its fast growing and ground covering ability. Global pulse production was about 73 million tonnes from an area of 80.8 million ha. In India, average yield of cowpea was 648 kg/ha as against world's average yield 904 kg/ha (FAO, 2016). In India, cowpea is mainly cultivated in the states of Rajasthan, Gujarat, Karnataka, Tamil Nadu, Maharashtra and some places in other state (Lokesh, 2017). However, the prevalent crop varieties are low yielding. So selection for high yielding line is desirable.

In self-fertilizing crop like cowpea, variability can be created by hybridization programme between selected plants, having desirable traits, and subsequent selection. Yield is a complex trait and results from the interaction of several factors such as genetic, physiological and environmental factors. Success of a crop improvement programme mainly depends on choice of an appropriate breeding/selection method and on the extent of variability present in the material. Therefore, before commencing any selection programme to develop high yielding plant type, it is essential to have knowledge about the magnitude of variability and inter-relationship among different traits, which are associated with yield, in the material. Hence, the objective of this study was to estimate the genetic variability, heritability and genetic advance of different traits related to grain yield in segregating population of cowpea derived from crosses which includes four varieties and four cultures.

Materials and Methods

The study was carried out at Department of Plant Breeding and Genetics, Agriculture College and Research Institute, Madurai, Tamil Nadu, India during *Kharif* 2018. Materials selected for this study consisted of F_2 generation of nine crosses *viz*., CO2 × VCP-09-019, CO2 × VCP-12-008,

CO4 × VCP-12-008, CO4 × VCP-09-013, CO4 × VCP-09-024, CO6 × VCP-09-024, CO 7 × VCP-09-013, CO 7 × VCP-09-019, CO 7 × VCP-09-024 and CO 7 × VCP-12-008. These crosses were selected based on general combining ability, hundred grain weight (g)and single plant yield (g) in F_I generation. F_2 plants were sown along with parents in 45 x 15 cm spacing. Observations were recorded in all the individual plants in each cross combination at physiological maturity on yield and yield attributing traits *viz*.,days to 50% flowering, plant height (cm), number of clusters per plant, number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, 100 seeds weight (g) and seed yield per plant (g). Data recorded from F_2 generation were statistically analyzed for estimating variability parameters like phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2) and genetic advance as per cent of mean (GAM) by adopting the formula given by Johnson *et al*.(1995).

Results and Discussion

The results of various genetic components *viz*., phenotypic coefficient of variation(PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2), genetic advance as per cent of mean (GAM) and grand mean (GM) for nine characters in F_2 generation for the crosses *viz*., cross I (CO2 × VCP-09-019), cross II (CO4 × VCP-12-008), cross III (CO4 × VCP-09-013), cross IV (CO4 × VCP-09-024), cross V (CO6 × VCP-09-024), cross VI (CO 7 × VCP-09-013), cross VII (CO 7 × VCP-09-019), cross VIII (CO 7 × VCP-09-024) and cross XI (CO 7 × VCP-12-008) were presented in the Tables 1- 9. In this study, low PCV and GCV were observed for days to 50% flowering for all the crosses except cross IV which showed high PCV and GCV for that trait. High heritability with high GAM was recorded in cross IV. High heritability with low GAM and high heritability with moderate GAM were obtained in cross I,II,III,V,XI and cross VI,VII, VIII,respectively. High heritability with high GAM for days to 50% flowering was reported by Anamika and Tajane (2014) and Bhadru and Navale (2012). Sandeep (2014) reported the similar result as low PCV and GCV for days to 50% flowering.

For plant height (cm) high level of GCV, PCV, heritability and GAM were obtained for all the crosses except cross VIII which possessed the moderate level of GCV, PCV, heritability and GAM for that trait. Similar reports for high level of GCV and PCV were found by Gondhalekar (2013) and Khan *et al.* (2015). Dinesh *et al.* (2017) reported the high level of GCV, PCV, heritability and GAM for plant height (cm).High level of GCV, PCV, heritability and GAM were obtained in all the crosses for the trait number of branches per plant except cross VIII which showed the moderate level of GCV, PCV, heritability and GAM for number of branches per plant. Khan *et al.* (2015) reported the similar finding like high level of GCV, PCV, heritability and GAM for number of branches per plant.

High level of GCV, PCV, heritability and GAM were recorded in all the crosses for the trait number of clusters per plant, number of pods per plant and single plant yield (g). Manggoel *et al.* (2012), Khan *et al.* (2015) and Lokesh (2017) found the similar results for trait number of clusters per plant and number of pods per plant. For single plant yield (g) high level of GCV, PCV, heritability and GAM were reported by Khan *et al.* (2015), Chattopadhyay *et al.* (2014), Sandeep *et al.* (2014) and Tigga *et al.* (2014). Moderate heritability and GAM were found by Lokesh (2017) for single plant yield. Moderate level of PCA and GCA, high level of heritability and GAM were obtained for all the crosses for the trait pod length except cross II which showed a low and moderate level of GCV and GAM for this trait. Chattopadhyay *et al.* (2014) reported the similar findings for pod length.

High level of heritability and GAM were observed for the trait number of seeds per pod except cross II which showed a moderate level of GAM for it. High level of heritability was also obtained for the trait hundred seeds weight (g) except cross VI. The results showed that the phenotypic coefficient of variance was greater than that of genotypic coefficient variation for all traits which indicated less environmental effect on all the traits. Therefore, the selection of these traits based on phenotypic value may be effective(Inuwa *et al.*, 2012,Kumar *et al.*, 2013, Tigga *et al.*, 2014). High heritability accompanied with high genetic advance for the above mentioned traits indicated that the traits are controlled by additive gene action and the directional phenotypic selection for these traits in F_2 population would be effective for crop improvement. Further improvement of these traits can be done by applying pedigree selection and by population improvement by recurrent selection for *gca*. High heritability coupled with low GAM indicated the presence of non-additive gene action. In crop improve improvement programme, it could be essential to have simultaneous selection of more than one character. In conclusion, the variability identified in the F_2 populations of different crosses of cowpea will provide a greater scope for getting superior individuals in further generation which may be useful in further crop improvement programme.

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Table 1.Variability parameters of various crosses in F_2 generation for days to 50% flowering

S. No	Crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	5.65	5.14	82.89	9.64	46.33
2.	**CO 4 × VCP-12-008**	5.63	4.90	75.68	8.78	49.42
3.	**CO 4 × VCP-09-013**	4.26	4.08	91.62	8.04	46.60
4.	**CO 4 × VCP-09-024**	37.91	37.83	99.56	77.76	106.87
5.	**CO 6 × VCP-09-024**	3.91	3.04	60.42	4.87	46.49
6.	**CO 7 × VCP-12-008**	7.32	6.47	78.04	11.77	43.83
7.	**CO 7 × VCP-09-013**	9.18	8.96	95.45	18.04	47.38
8.	**CO 7 × VCP-09-019**	7.26	6.97	92.12	13.77	45.23
9.	**CO 7 × VCP-09-024**	5.76	5.24	82.89	9.83	45.41

Table 2.Variability parameters of various crosses in F_2 generation for plant height (cm)

S. No	Crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	31.95	31.92	99.85	65.71	72.93
2.	**CO 4 × VCP-12-008**	36.98	36.90	99.52	75.82	120.60
3.	**CO 4 × VCP-09-013**	37.91	37.83	99.56	77.76	106.87
4.	**CO 4 × VCP-09-024**	43.33	43.24	99.57	88.87	107.62
5.	**CO 6 × VCP-09-024**	25.08	25.04	99.73	51.52	71.61
6.	**CO 7 × VCP-12-008**	31.01	30.86	99.05	63.28	50.19
7.	**CO 7 × VCP-09-013**	53.22	53.20	99.90	109.53	56.63
8.	**CO 7 × VCP-09-019**	18.60	18.37	97.49	37.36	55.13
9.	**CO 7 × VCP-09-024**	36.90	36.87	99.85	75.90	63.14

Table 3.Variability parameters of various crosses in F_2 generation for number of branches per plant

S. No	Crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	43.34	43.28	99.73	89.03	3.13
2.	**CO 4 × VCP-12-008**	43.96	43.61	98.44	89.13	1.82
3.	**CO 4 × VCP-09-013**	41.88	41.77	99.48	85.82	3.30
4.	**CO 4 × VCP-09-024**	40.16	39.97	99.08	81.96	2.60
5.	**CO 6 × VCP-09-024**	35.53	35.53	100.00	73.19	2.61
6.	**CO 7 × VCP-12-008**	44.48	44.42	99.69	91.36	2.87
7.	**CO 7 × VCP-09-013**	40.94	40.82	99.44	83.85	3.25
8.	**CO 7 × VCP-09-019**	19.61	19.46	98.48	39.78	2.93
9.	CO 7 × VCP-09-024	36.86	36.81	99.73	75.73	3.68

Table 4.Variability parameters of various crosses in F_2 generation for numberof clusters per plant

S. No	Crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	83.12	83.07	99.89	171.02	8.73
2.	**CO 4 × VCP-12-008**	38.42	38.29	99.32	78.60	5.46
3.	**CO 4 × VCP-09-013**	45.20	45.09	99.52	92.67	5.04
4.	**CO 4 × VCP-09-024**	25.33	24.92	96.79	50.50	5.83
5.	**CO 6 × VCP-09-024**	43.52	43.46	99.71	89.39	7.36
6.	**CO 7 × VCP-12-008**	45.36	45.25	99.54	93.01	6.93
7.	**CO 7 × VCP-09-013**	59.52	59.49	99.89	122.48	10.58
8.	**CO 7 × VCP-09-019**	61.83	61.71	99.60	126.86	6.03
9.	**CO 7 × VCP-09-024**	65.67	65.63	99.89	135.12	11.05

Table 5.Variability parameters of various crosses in F_2 generation for number of pods per plant

S. No	Crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	67.61	67.57	99.90	139.13	18.73
2.	**CO 4 × VCP-12-008**	40.71	39.34	93.37	78.31	12.14
3.	**CO 4 × VCP-09-013**	51.46	51.15	98.80	104.73	12.53
4.	**CO 4 × VCP-09-024**	21.37	20.81	94.85	41.75	11.30
5.	**CO 6 × VCP-09-024**	51.38	51.32	99.77	105.59	15.70
6.	**CO 7 × VCP-12-008**	52.71	52.67	99.86	108.43	12.28
7.	**CO 7 × VCP-09-013**	57.18	57.15	99.87	117.64	16.42
8.	**CO 7 × VCP-09-019**	61.97	61.95	99.92	127.57	14.30
9.	**CO 7 × VCP-09-024**	59.23	59.20	99.90	121.89	21.38

Table 6.Variability parameters of various crosses in F_2 generation for pod length

S. No	crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	13.75	13.69	99.14	28.09	14.67
2.	**CO 4 × VCP-12-008**	10.88	8.52	61.30	13.74	15.10
3.	**CO 4 × VCP-09-013**	15.21	14.50	90.86	28.46	13.84
4.	**CO 4 × VCP-09-024**	15.71	15.25	94.31	30.51	12.23
5.	**CO 6 × VCP-09-024**	11.33	11.12	96.27	22.47	13.70
6.	**CO 7 × VCP-12-008**	11.38	10.86	91.21	21.37	12.40
7.	**CO 7 × VCP-09-013**	12.57	12.52	99.25	25.69	14.50
8.	**CO 7 × VCP-09-019**	15.23	15.14	98.78	30.99	12.63
9.	**CO 7 × VCP-09-024**	16.08	16.01	99.14	32.83	12.55

Table 7.Variability parameters of various crosses in F_2 generation for number of seeds per pod

S. No	crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	14.74	14.49	96.59	29.34	12.19
2.	**CO 4 × VCP-12-008**	15.21	11.84	60.68	19.01	14.09
3.	**CO 4 × VCP-09-013**	28.87	28.01	94.12	55.98	11.11
4.	**CO 4 × VCP-09-024**	14.58	14.06	93.05	27.94	11.04
5.	**CO 6 × VCP-09-024**	18.58	18.40	98.12	37.54	11.77
6.	**CO 7 × VCP-12-008**	16.16	16.08	99.00	32.95	10.72
7.	**CO 7 × VCP-09-013**	64.97	64.96	99.96	133.79	14.64
8.	**CO 7 × VCP-09-019**	20.22	20.11	98.88	41.19	10.97
9.	**CO 7 × VCP-09-024**	17.85	17.54	96.59	35.51	10.07

Table 8.Variability parameters of various crosses in F_2 generation for hundred seeds weight (g)

S. No	crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	7.14	7.02	96.59	14.21	9.29
2.	**CO 4 × VCP-12-008**	96.30	94.68	96.65	191.75	9.01
3.	**CO 4 × VCP-09-013**	19.69	16.15	67.32	27.30	7.72
4.	**CO 4 × VCP-09-024**	10.25	10.25	100.00	21.12	8.39
5.	**CO 6 × VCP-09-024**	17.00	16.88	98.60	34.52	7.85
6.	**CO 7 × VCP-12-008**	9.40	5.70	36.75	7.12	9.69
7.	**CO 7 × VCP-09-013**	19.36	18.42	90.57	36.12	9.44
8.	**CO 7 × VCP-09-019**	8.90	8.76	96.92	17.77	9.06
9.	**CO 7 × VCP-09-024**	6.92	6.80	96.59	13.76	9.59

Table 9.Variability parameters of various crosses in F_2 generation for single plant yield (g)

S. No	crosses	PCV %	GCV %	h^2 (BS) %	GAM %	GM
1.	**CO 2 × VCP-09-019**	70.64	70.62	99.95	145.44	21.92
2.	**CO 4 × VCP-12-008**	56.79	53.67	89.33	104.50	13.94
3.	**CO 4 × VCP-09-013**	50.49	49.43	95.86	99.70	11.64
4.	**CO 4 × VCP-09-024**	27.85	27.36	96.56	55.39	10.42
5.	**CO 6 × VCP-09-024**	70.00	69.93	99.81	143.92	14.96
6.	**CO 7 × VCP-12-008**	59.59	59.58	99.97	122.72	13.14
7.	**CO 7 × VCP-09-013**	53.34	53.33	99.98	109.85	19.53
8.	**CO 7 × VCP-09-019**	68.55	68.54	99.95	141.15	14.73
9.	**CO 7 × VCP-09-024**	70.70	70.68	99.95	145.57	21.90

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